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PATENT SPECIFICATION

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DRAWINGS ATTACHED

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(54) ARTIFICIAL MINERAL FIBRES

(71) We, CIMENTS LAFARGE, a Corporation organised under the laws of France, of 28, Rue Emile Menier, Paris (Seine), France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to artificial mineral fibres, and also to a method of manufacturing such products by the fibrillation of molten mineral oxides. The invention extends to the use of the new fibres for the manufacture of building materials having improved properties.

It is known that during the last fifteen to twenty years artificial mineral fibres have been used more and more in the place of natural fibres, particularly for reinforcing certain materials or for applications such as heat or sound insulation. The increasing use of artificial fibres is due to the fact that the cost price of natural fibres is higher and that, in addition, the number of natural fibres available on the market is restricted to less than ten or so types. The new practical needs impose upon fibres conditions of utilisation of increasing diversity, both from the physical and chemical points of view. These new applications, as well as economic demands, lead to the creation of new kinds of mineral fibres more suited to the requirements specified. In previous art, various type of artificial mineral fibre have been proposed, as well as methods for obtaining them. Among these known processes may be mentioned the drawing of molten glass baths through platinum or tungsten drawplates, acicular crystallisation in a molten medium, precipitation from colloidal solutions, pyrolytic deposition or the sudden cooling of a liquid able to form glass.

Moreover, it is known, for example from U.S. Patent No. 2,020,403, that it is possible to manufacture mineral fibres by cooling with a current of compressed air a flow of molten mineral oxide.

The invention relates to fibres obtained by the fibrillation of a molten oxide composition, the fibres being non-vibreous and having wollastonite (calcium metasilicate) as their principal constituent, and the composition comprising the following oxide analysis in terms of percentage by weight:

SiO_2	:	40—60%
Al_2O_3	:	0—15%
CaO	:	>30
Fe_2O_3	:	0—3%
alkali metals	:	0—8%

the percentage of SiO_2 being greater than the percentage of CaO.

The above composition may be obtained by the well known method of melting raw materials containing the oxides required in the correct proportions. For example, the raw material may be a homogeneous mixture of clay and limestone, which may be melted in a kiln using external heating. The iron oxide FeO is formed when the partial pressure of the oxygen of the gaseous atmosphere in the melted oxide mixture kiln is decidedly lower than that in air at the same temperature.

It will be observed that the molten oxide compositions which may be used according to the invention are not vitreous. It is therefore rather surprising that stable fibres should be obtained from such compositions. Thus, the content of matrix forming constituent, such as silica, is smaller than that which would appear necessary for obtaining mineral fibres.

It has been previously indicated that the method of obtaining fibres from the compositions which have just been defined consists in subjecting a stream of molten material to the action of a compressed gaseous fluid, such as air, used at a speed and rate of flow sufficient to give rise to fibrillation.

Generally speaking, the best fibrillation is obtained by subjecting to the action of the compressed fluid a stream of molten material the temperature of which is at least 200°C higher than the theoretical melting point. It has been found, indeed, that it was advantageous to use the molten material at as high a temperature as possible.

It will also be observed that it is possible to use jets of fluids other than air, for example a high speed steam jet, in which case fibres are obtained which have a coarser structure than those obtained under similar conditions with a jet of compressed air.

The practical methods of carrying out the fibrillation vary essentially according to the conditions of formation of the stream of molten mixture and to the properties of said mixture, on the one hand, and according to the conditions of utilisation of the gaseous flow, on the other hand. In addition, the particular type of fibres required will depend upon the application envisaged therefor.

Those skilled in the art may derive from the general description herebelow and the specific examples given the information indicating for any particular case those conditions of fibrillation likely to give good results or best suited in relation to the intended application of the fibres produced.

The essential factors which make it possible to obtain fibrillation are, for a given rate of flow of molten matter, the rate of flow and the velocity of the gas stream. These two parameters permit adjustment of the shape and the quantity of fibres obtained. There exists in each case a threshold of velocity and of rate of flow of the gas stream above which fibres are produced. In fact, the jet of compressed air first divides the stream of molten material, on which it impinges then tends to draw out in the direction of flow of the gas and thus produces the fibres. If the compressed gas jet has only a low pressure, the molten material merely divides into a very large number of small balls or spheres, which may be hollow and the diameter of which varies, for example, between 0.1 and 5 mm. This technique may be used to advantage for obtaining more or less porous balls, making possible the manufacture of light materials.

The rate of flow and velocity values of the gas jet which correspond to the fibrillation threshold depend obviously on the rate of flow of the molten material, its physical-chemical nature, its rheological properties, its temperature and other factors.

When the velocity of flow of the gas is increased above this threshold, fibres are produced. The length of the fibres increases and their section decreases as the velocity of the gas jet increases. High velocities of the gas jet thus make it possible to obtain long, fine fibres particularly well suited for applications as reinforcement products.

The relative arrangement of the gas jet and of the stream of molten material also influences fibrillation. A conventional arrangement consists in causing the high velocity gas jet to impinge on the stream of molten material at right angles to the axis of flow of the latter. The air jet and the stream of material may or may not be concurrent. When the jets are concurrent, the energy of the gas jet must be high for the entirety of the stream of molten material to be fibrillated. If, in the case where the axes of the jet and stream are concurrent, the energy of the gas jet is not sufficient, the molten material is transformed into granules and not fibres. With the same rate of flow of air, however, it is possible to obtain fibres by arranging the jet and stream with their axes at right angles, but in such a way that the air jet impinges tangentially with the stream of molten material. In that event, fibres are obtained which conform to the requirements of the invention.

Alternatively, the gas jet parameters may be fixed, and the stream of molten material varied in order to obtain complete fibrillation.

As a practical illustration, for a rate of flow of molten material of 1 litre per minute, a jet of compressed air is used at a very high velocity and rate of flow, a jet from an 8 mm nozzle supplied at a pressure of 6 bars being suitable. For this purpose, a compressor having a capacity of 10 cubic metres per minute is suitable as a source of compressed air. These figures are given as a guide only, the exact figures used being in no way critical.

It is possible to recover the fibres produced in a chamber from which air is withdrawn by means of a fan mounted on the wall of the chamber opposite that where the fibres enter. The fibres then collect at the bottom of the chamber.

The fibres according to the invention may be used in all applications suitable for artificial mineral fibres. They may in particular be used to reinforce mortar in building materials. In that way, there are used to advantage their very high modulus of elasticity and their mechanical resistance/elasticity modulus ratio which is greater than that exhibited by the same material in any polycrystalline form. It will be observed, for example, as an indication, that the fibres of the invention may have tensional breaking stress values of the order of 200 to 300 kg/mm^2 for an average fibre diameter of 5 microns.

The fibres may also be used to form highly porous structures without harming the cohesion of the building material obtained, which obviates the drawbacks of certain previous porous materials, for example "foam" concretes.

The fibres according to the invention pro-

vide an important advantage in these various applications in that they have much the same nature as the cement with which they are incorporated for the manufacture of building materials. Thus, the materials in fibre form obtained from the above-mentioned compositions are compatible, from the physico-chemical point of view, with the artificial or aluminous cement mortars. It is thus possible to make fibrous concretes the binder content of which may be up to 30% by weight. It should be noted that for certain uses, the hydraulic binder may be replaced by a mineral or organic chemical binder. These fibrous concretes may be utilized for heat-proofing and sound-proofing panels, or as high tensile strength concretes, if the fibres are aligned along the direction of stress.

The invention is illustrated but not limited by the examples hereinunder, and with reference to the attached drawings in which

Fig. 1 is an elevation and diagrammatic cross-section showing a device for obtaining fibres according to the invention.

Fig. 2 is a plan view from above of the device of Figure 1.

The device diagrammatically represented in Figures 1 and 2 comprises a standard reverberatory furnace in which an oxide mixture 2 is melted. This mixture flows into a cylindrical channel 3 with approximately 30° inclination. At the downstream end of the channel 3, the molten material 2 forms a descending vertical stream 6. A tube 4 is connected to a source of compressed air and ends in a nozzle 5.

The jet 7 of compressed air comes out of nozzle 5 in a direction at right angles to that of the stream 6. Moreover the jet 7 impinges tangentially on the stream 6. The fibres 8 are obtained by entrainment of the stream 6 by the air 7 and by the sudden cooling of the molten material.

According to an arrangement which is not shown in the drawing, the fibres 8 may be drawn towards a filtering surface by creation of a depression in the region 9 surrounding the stream of material undergoing fibrillation.

In the following example, the device just described was used for the fibrillation of a particular molten oxide composition.

Example

A homogeneous mixture of clay and limestone having the following composition by weight was melted in the reverberatory furnace 1:—

Oxide	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Alkali Metals
%	52	8	0.5	35	0.5	4.0

This mixture was allowed to run at a temperature of 1500—1555° (into the channel 3, so as to provide a stream 6 having a cross-section in the order of a few square centimetres. The velocity of the stream 6 of molten material was in the order of 1 to 3 m/s. Compressed air was supplied by a mobile compressor maintaining a 0.15 cubic metre tank at a constant pressure of 7 kg/cm². The cylindrical tubing 4 had a diameter of 20 mm and the nozzle 5 had a section of 20 mm ×2.5 mm. The rate of air flow through the nozzle 5 was 3Nm³/min, and the average velocity of the air in the order of 60 m/s.

Mineral fibres were obtained, the amount thereof being increased by using higher rates of air flow. The average length of the wollastonite fibres produced depends upon the temperature of the molten material; when this temperature was very little above the melting point, long and thick fibres were obtained which reached, for example, 2—10 cm length with a diameter of 30 microns. On the other hand, with a higher temperature, these dimensions were reduced to 1—3 cm and 8 microns respectively.

The invention is not limited to the method of manufacture described with reference to the attached drawing. It is in fact possible to achieve the formation of fibres in various ways without departing from the scope of the invention. Thus, the molten material may be poured in the form of a wide, film like stream, the formation of the fibres being achieved by contact of this thin stream with a compressed air jet. It should be understood therefore that it is possible to modify within wide limits the technique utilized to fibrillate the molten oxide composition.

WHAT WE CLAIM IS:—

1) Fibres obtained by the fibrillation of a molten oxide composition, fibres being non-vitreous and having wollastonite (calcium metasilicate) as their principal constituent, and the composition comprising the following oxide analysis in terms of percentage by weight:

SiO_2	:	40—60%
Al_2O_3	:	0—15%
CaO	:	>30
Fe_2O_3	:	0—3%
Alkali metals	:	0—8%

the percentage of SiO_2 being greater than the percentage of CaO.

2) Fibres according to claim 1, wherein the composition has the following analysis in terms of percentages by weight:

SiO_2	:	52
Al_2O_3	:	8
CaO	:	35
Fe_2O_3	:	0.5
Alkali metals	:	4
MgO	:	0.5

3) A process for obtaining the mineral fibres of claim 1, wherein a stream of a molten oxide composition having the composition given in claim 1 and at a temperature greater by at least 200°C than its theoretical melting temperature, is subjected to the action of a jet of compressed gaseous fluid impinging on the stream at a speed and rate of flow sufficient to cause fibrillation.

4) A process according to claim 3 or 4, wherein the axis of the gas jet is at right angles to that of the stream of molten material, and the gas jet impinges tangentially on the stream of molten material.

5) A process according to claim 3 or 4, wherein the fibres are entrained towards a filtering surface, by setting up a depression in the area surrounding the stream of material undergoing fibrillation.

6) Mineral fibres according to claim 1, substantially as hereinbefore described.

7) A process according to claim 3 for obtaining mineral fibres, substantially as hereinbefore described with reference to the accompanying drawings.

8) Concretes comprising fibres according to any of claims 1, 2 or 6, or manufactured by the process of any of claims 3—5 or 7.

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1273205 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig. 1

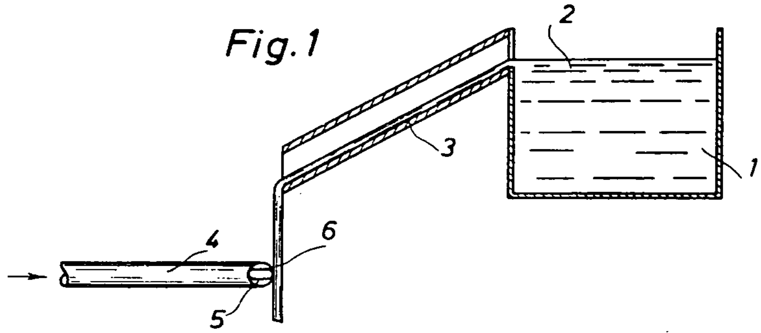

Fig. 2